A Standard for Training and Qualification of Criticality Safety Engineers, ANSI/ANS-8.26

J. A. Morman
Argonne National Laboratory

J. McKamy
U. S. Department of Energy

Summary

Development of an ANSI/ANS Standard for the training and qualification of criticality safety engineers has been underway for nearly one year. The working group for this Standard is comprised of criticality safety experts from regulatory, licensee and contractor organizations. Its goal is to develop a standard that can be uniformly adopted, that covers all criticality safety engineer qualification levels, and that includes all required competencies such that most of the qualifications can be easily transferred between sites. This status report is presented to let the general criticality safety community know of progress on the Standard, and to solicit feedback to the working group as it continues work on ANSI/ANS-8.26.

Introduction

Development of a standard for the training and qualification of nuclear criticality safety engineers has long been a topic of discussion within the criticality safety community. The training working group of the Nuclear Criticality Technology Safety Project debated the usefulness of establishing a unified standard for the qualification and certification of criticality safety professionals frequently during the past fifteen or so years. The Defense Nuclear Facilities Safety Board (DNFSB) noted the need for continuing training in its Recommendation 97-2. In the implementation plan in response to Recommendation 97-2, the Department of Energy (DOE) created the Nuclear Criticality Safety Program that included a subtask specifically aimed at the training and qualification of criticality safety professionals. One product of this subtask is DOE-STD-1135-99, *Guidance for Nuclear Criticality Safety Engineer Training and Qualification.* DOE field offices and contractor facilities now develop criticality safety training plans according to this standard.

In a parallel development, the Education Committee of the Nuclear Criticality Safety Division of the American Nuclear Society (ANS) is developing a series of white papers to address the question of what training is required of criticality safety engineers. Currently two standards within the ANSI/ANS-8 series treat criticality safety training. ANSI/ANS-8.20, *Nuclear Criticality Safety Training*, is a rather detailed description of the training program elements required for personnel who perform operations with fissile material. However, as stated in the scope of this Standard, it “is not sufficient for the training of nuclear criticality safety staff.” ANSI/ANS-8.19, *Administrative Practices for Nuclear Criticality Safety*, contains several general statements that recommend maintenance of a criticality safety training program and providing personnel with the appropriate technical background. The Nuclear Regulatory Commission (NRC) adopts these two Standards in Regulatory Guide 3.71 (1998).

Changes in the DOE mission and contracting practices have also changed with time and affected the expectations for criticality safety engineers and their professional development. Historically, long-term management-and-operating contractors hired young engineers and scientists and provided a stable mentoring environment for them to develop the expertise needed to be a proficient criticality safety engineer. Twenty years ago the funding for safety organizations was typically an overhead item with staffing levels funded at level-of-effort needs. This provided the time for criticality safety engineers to acquire the intimate knowledge of fissile material processes and facilities needed to develop good criticality safety limits and controls. As DOE transitioned to a cleanup-oriented mission and to management-and-integration contracts, the role of the criticality safety engineer has often been one of providing evaluations and controls for one-of-a-kind processes, often from a distance by subcontracted criticality safety staff. Funding for criticality safety staff now mostly comes directly from line organizations focused on a task, not on developing or retaining criticality safety expertise. These developments have produced new challenges to ensuring that criticality safety engineers developing limits and controls for DOE operations are appropriately qualified technically and familiar with the operations they are attempting to analyze.

At this point in time, however, there is no high-level guidance or standard that can be uniformly adopted by NRC, DOE and DOE contractors as defining the requirements for training and qualification of criticality safety engineers. With the goal of creating such a standard, it was moved at the March 2000 meeting of ANS-8 that a new working group be formed to develop an ANSI/ANS Standard for the training and qualification of criticality safety professionals. In July 2000, the formal request was submitted to initiate the project and approval was voted by ANS-8 at the end of August to pursue development of ANSI/ANS-8.26, *Criticality Safety Engineer Training and Qualification Program*. A working group was formed that includes representatives of the DOE, the NRC, the DNFSB staff, DOE contractors, NRC licensees and experts in training.

Development and Status of the Standard

The goal of the ANS-8.26 working group is to develop a Standard that captures all of the required competencies for criticality safety engineers (CSEs) without being overly prescriptive in how those competencies are to be achieved. The Standard starts with the recommendation to maintain and document a criticality safety training program. The program should be implemented in such a way that all the elements of the training and qualification program are auditable. The program should also include features for continuing professional development and requalification.

The Standard needs to identify training requirements for every stage of the criticality safety engineer's professional development. The approach decided upon by the working group thus far is to identify categories of criticality safety engineers and then associate levels of training with each category. Currently three engineer levels have been included: Criticality Safety Engineer Trainee (CSET), Criticality Safety Engineer and Senior Criticality Safety Engineer (SCSE). Originally, a special category for the criticality safety analyst was included, but later incorporated into the other levels.

The definitions of the qualification levels are nearly self-explanatory. The Criticality Safety Engineer Trainee is one who has just entered the field of criticality safety and performs only limited parts of criticality safety evaluations or reviews based on his background and experience. Ideally, the Trainee learns under the guidance of a mentor. A Criticality Safety Engineer is fully qualified to perform complete criticality safety evaluations. The CSE must have the ability to model systems, perform calculations as needed, be familiar with the authorization basis of his facilities and have extensive knowledge of the operations at those facilities. The SCSE must have all of the training of the CSE, but through years of experience has a deeper understanding of his subject matter, the history and operations of his facilities, and the integrated safety program at those facilities.

Clearly, trying to define the competencies and the levels of training associated with each CSE level is not an easy task. Different sites and even different facilities within a site often have different training requirements for persons with the CSE job description. DOE-STD-1135-99 was drafted by a group that represented a reasonably good cross section of DOE interests and the list of training and qualification requirements in that standard encompasses most, if not all, of the areas of expertise needed by the CSE. Therefore, the 8.26 working group decided to use DOE-STD-1135-99 as a starting point to define the training requirements for the CSE, but without the prescriptive details in that DOE standard.

In addition to a minimum academic requirement, the ten areas of expertise outlined in the current draft of 8.26 are: nuclear theory; calculational methods; critical experiments and data; rules, standards and guides; nuclear criticality safety evaluations; safety analysis and control; criticality alarm and detection systems; accountability practices; hands-on experimental training; facility and process knowledge. It is typically assumed that the CSE will have at least a B. S. degree in nuclear engineering, nuclear physics or a related field. Exceptions to this requirement must be addressed on a case-by-case basis.

The intent of Standard 8.26 is to define the scope of required knowledge in each area, while minimizing the prescription of how to attain that knowledge or the detailed content of each subject area. Suggested sources of training in each competency area might be included in an appendix to the standard. The following general guidance is being considered by the working group in each of the ten areas. As work on the standard continues, these items will be written in the usual ANSI/ANS format as recommendations, suggestions or permissions.

Nuclear Theory

The CSE must have a thorough understanding of the fission process and the factors that affect the reactivity of fissionable systems, including reflection, moderation, array interactions and the presence of neutron poisons.

Calculational Methods

The CSE must know how to use the various calculational tools that are typically employed in the development of criticality safety evaluations. These tools include common hand calculation methods such as buckling conversion and surface density, deterministic codes such as ANSISN and DANTSYS, and the Monte Carlo codes such as MCNP, KENO and MONK. The CSE must also know the limitations of each of these tools and the correct way to validate their use.

Critical Experiments, Accidents and Data

This competency is included to ensure that the CSE is familiar with the critical experiments that are available as reference or benchmark configurations and with the data available to be used in criticality safety analyses. The CSE should know how cross section sets used in calculations are derived and their limits and range of applicability. Review of past criticality accidents and the lessons learned provide important background information when developing contingency scenarios.

Rule, Standards and Guides

While it should be obvious that the CSE must know the rules and standards under which his facilities operate, it is important to formalize this training requirement. Typically, a list of required reading is generated that incorporates all high-level documents plus site-specific rules and procedures.

Nuclear Criticality Safety Evaluations

One of the more important functions of the CSE is the preparation of criticality safety evaluations. These evaluations not only demonstrate the subcriticality of operations, but generally also include derivation of limits and controls for the operations. Double contingency analysis is an integral part of the criticality safety evaluation. This competency is normally achieved by developing evaluations under the guidance of a mentor, or working in conjunction with experienced CSEs.

Safety Analysis and Control

Criticality safety is an integral part of the overall safety program for any facility that operates with fissionable materials. In many cases, controls derived in the criticality safety evaluation are included in the authorization basis documents for the facility. Often controls are included as technical safety requirements in those documents. The CSE must be aware of the authorization basis of the facility and any impact that criticality safety controls might have on that basis.

Criticality Alarm and Detection Systems

At facilities with criticality alarm or detection systems, the CSE must be able to evaluate the need for the alarm system and determine the correct placement and coverage of the system.

Accountability Practices

Material accountability is an integral part of criticality safety. Accountability systems can be computer-based or completely manual. The CSE must know the reliability and accuracy of the overall system as it applies to specific operations to properly just the effectiveness of controls in the criticality safety evaluation. Part of this competency is knowing the accuracy and limitations of any assay techniques relied upon to produce accountability values including sampling, destructive analysis, and the various non-destructive assay methods that determine fissile content of process streams or batch materials.

Hands-on Experimental Training

Hands-on training with critical and subcritical assemblies promotes a better understanding of the factors that contribute to criticality safety and allows a real-time experience of neutron multiplication effects as assemblies are put together. There are limited training resources for this competency, and is usually achieved by attending the courses at Los Alamos National Laboratory or through work experience at a critical experiments facility.

Process and Facility Knowledge

In order to properly perform criticality safety evaluations and review operations for criticality safety, the CSE must have a thorough knowledge of the facilities and material processes within those facilities for which he is responsible. This knowledge is normally obtained through facility-specific training courses, facility walk-downs, discussions with operators and facility management and review of facility documentation. As part of this training requirement, the CSE is expected to spend a reasonable fraction of his time on the operating floor.

Within the framework outlined above, the 8.26 working group will attempt to quantify the level of training required in each subject area for each level of qualification, balancing the need for appropriate academic background with the need for actual operating-floor experience.

Although still in the early stages of development, several important principles have been identified as being essential to this standard. First, non-site specific elements of the qualification program should be transferable between sites. That is, once the basic training requirements have been achieved, there should be no need to repeat them at another site that applies the same standard. Only site-specific training would have to be completed. Second, training by experience must be taken into account. Many experts in the field of criticality safety have gained their expertise through years of hands-on experience, not by earning advanced degrees. Third, interactions with operating personnel and facility management must be stressed. The role of the criticality safety engineer is to assist operating personnel to minimize the risk of a criticality accident by establishing appropriate controls and limits. To effectively do this, criticality safety staff must spend adequate time in the operating facilities working with their staff.

The ANS-8.26 working group faces a challenging task. By interacting often with the user community, this standard will develop into one that defines a qualified criticality safety engineer without imposing undue constraints on management or the criticality safety staff, and will minimize the necessity for repeated training as people move ahead in their careers.